

UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
BERKELEY, CALIFORNIA

CIRCULAR 316

OCTOBER, 1929

ELECTRICAL STATISTICS FOR CALIFORNIA FARMS

B. D. MOSES¹



TYPICAL ELECTRICAL INSTALLATION FOR IRRIGATION PUMPING

FOREWORD

This bulletin is a contribution of the Division of Agricultural Engineering, and the Committee on Statistics of the California Committee on the Relation of Electricity to Agriculture. It is the fourth of a series planned to report the results of investigations conducted

¹ Associate Professor of Agricultural Engineering and Associate Agricultural Engineer in the Experiment Station.

jointly by the Agricultural Experiment Station, College of Agriculture, University of California, and the California Committee on the Relation of Electricity to Agriculture.² This committee represents the agricultural and electrical industries in California that are working together for the purpose of making reliable information available concerning the use of electricity on the farm, and cooperating with similar committees in other states.

E. D. MERRILL,

Director, California Agricultural Experiment Station.

INTRODUCTION

The Agricultural Engineering Division of the University of California has received many inquiries for statistics on the uses of electricity in California agriculture. Some of these inquiries have come from farmers seeking an account of the success obtained by others, as a help in making their own installations; farm organizations have wanted data on rural electrification that would be of value to their members; manufacturers have requested figures that would assist them in determining the most practical apparatus to manufacture, and which would also help in determining sales and advertising policies; power utilities have been interested in the character of equipment used on the farm; publishers of farm papers and magazines want the figures and facts in order to picture correctly farm practices; and investigators of rural electrification use such information as a guide to further study.

² The personnel of this committee for 1929-30 is:

E. D. Merrill, College of Agriculture, Chairman.
H. B. Walker, College of Agriculture, Vice-Chairman.
N. R. Sutherland, Pacific Gas & Electric Co., Treasurer.
B. D. Moses, College of Agriculture, Director-Secretary.
J. R. Tavernetti, College of Agriculture, Field Engineer.
C. L. Cory, College of Mechanics.
H. M. Crawford, Pacific Gas & Electric Co.
W. J. Delehanty, General Electric Co.
J. J. Deuel, California Farm Bureau Federation.
A. M. Frost, Great Western Power Corporation.
Charles Grunsky, California Railroad Commission.
Alex. Johnson, California Farm Bureau Federation.
T. H. Lambert, Agriculturist.
R. C. McFadden, Southern California Edison Co.
W. C. McWhinney, Southern California Edison Co.
E. G. Stahl, San Joaquin Light & Power Corporation.
George Tenney, McGraw-Hill Publishing Co.

In order to obtain material to meet these demands, a committee³ was appointed to accumulate statistics for the year 1925, and a second committee⁴ was appointed to study the returns and publish the findings.

It was found that the farmers of California consumed, in 1925, over one billion horsepower-hours of electrical energy for power uses only, and that this consumption is increasing at a rate of approximately 10 per cent a year. Old methods have been improved and new devices made practical to such an extent that now many farms are well equipped with electrical appliances and machinery.

The purpose of this report is to place before the farmer information that may help him in the application of electricity to his farming methods and home conveniences, and to provide others interested in agriculture with accurate data upon present uses and possible developments.

Three direct methods have been used in making a survey of the field:

(1) The power utilities of California were sent a questionnaire concerning the electricity used in agriculture on their own lines.

(2) California farmers on power company lines were mailed a postcard questionnaire regarding the amount of electricity and the number of electric appliances used.

(3) The California Railroad Commission furnished statements covering the annual reports made by the privately owned utilities on their agricultural loads.

The results of these returns have been carefully studied and arranged in tabular form. They are presented and discussed in the following pages.

POWER COMPANY QUESTIONNAIRE

The purpose of the power company questionnaire was to obtain the gross figures on consumers, connected load, and revenue of the electricity sold by the utilities to farmers.

³ J. J. Deuel, California Farm Bureau Federation, San Francisco, Chairman.
A. G. Cage, Southern Sierras Power Co., Riverside.
Lloyd Henley, San Joaquin Light & Power Corporation, Fresno.
W. C. McWhinney, Southern California Edison Co., Los Angeles.
B. D. Moses, University of California, Davis.
N. R. Sutherland, Pacific Gas & Electric Co., San Francisco.

⁴ L. S. Wing, Engineer, California Farm Bureau Federation, San Francisco, Chairman.
B. D. Moses, Agricultural Engineering Division, University of California, Davis.
N. R. Sutherland, Pacific Gas & Electric Co., San Francisco.
C. M. Titus, Associate Statistician, Agricultural Experiment Station, Davis, California.

Most power companies have schedules that automatically classify the rural load, and also special agricultural power schedules for farm motors and heating units used in dehydraters, brooders, and incubators. The final segregation of the farm loads from this group was left to each individual company; and while those filling out the questionnaire were not always able to make exact segregations from their records, the acquaintance of the district managers with their individual customers, and the many studies that had been made by the company statisticians, permitted of fairly accurate estimates. In general, domestic lighting and heating are served through the same meter, and there is no way of telling from the watt-hour record how much electricity is used for each; an exact classification into "farmer" and "urban" is, furthermore, not always possible in what are known as the suburban and rural districts.

For the purpose of this survey a farm was defined as a "place that produces agricultural products and upon which either the owner, tenant, or hired help depends for his livelihood."

Following is the questionnaire sent to power companies:

ELECTRICAL POWER STATISTICS FOR CALIFORNIA

The following data are to be taken from the 1925 records:

- Power Company.....
1. Number of *Rural* consumers of *Electric Power*.....
 2. Number of *Rural* consumers using electric *Lights*.....
 3. Number of *Rural* consumers using electricity for *Heating or Cooking*.....
 4. Number of *Rural* consumers using electricity for *Power* purposes.....
 5. What per cent of the above classification do you estimate to be farmers?
i.e., Individuals depending upon farming for their livelihood.
Classification 1.....%
 - Classification 2.....%
 - Classification 3.....%
 - Classification 4.....%
 6. What was the total agricultural *Connected* load for 1925?.....horsepower
 7. What was the total *Consumption* by your agricultural consumers for
1925?.....kilowatt-hours
 8. What was the total *Revenue* from your agricultural load for 1925? \$.....
- Signed.....

The survey revealed that there were 72 public electric utilities in California in 1925, 21 of which served agricultural loads. Three of these had a gross annual agricultural revenue of from \$2,000,000.00 to \$4,000,000.00 each, and eight of the others averaged over \$300,000.00 each (see table 3).

Table 1 shows the extent to which electricity was used by all of the consumers living outside of incorporated towns. It includes both farmers and rural residents not engaged in farming. It does not,

however, include the larger industrial users such as packing houses and cement plants. It reveals the interesting fact that 186,560 or 89 per cent of the total number of rural consumers had electric lights; 13,650 or 6.5 per cent used electricity for heating and cooking, and 48,460 or 23 per cent used electricity for power purposes.

TABLE 1

NUMBER OF CONSUMERS OF ELECTRICITY RESIDING OUTSIDE OF INCORPORATED TOWNS OR CITIES IN CALIFORNIA, SERVED BY CENTRAL STATIONS; POWER COMPANY QUESTIONNAIRE, 1925*

Name of company	Lights	Heating and cooking	Power
Southern California Edison Company.....	94,060	4,580	13,450
San Joaquin Light & Power Corporation.....	15,220	1,490	8,870
Pacific Gas & Electric Company.....	45,360	2,940	13,540
Southern Sierras Power Company.....	3,470	430	1,390
Coast Counties Gas & Electric Company.....	5,090	320	1,470
Greast Western Gas & Electric Company.....	6,700	1,000	2,400
Coast Valleys Gas & Electric Company.....	800	80	560
Western States Gas & Electric Company.....	3,720	460	3,180
San Diego Consolidated Gas & Electric Company.....	4,150	820	1,350
Midland Counties Gas & Electric Company.....	2,710	260	850
Turlock Irrigation District.....	2,500	770	810
California Oregon Power Company.....	320	40	40
Escondido Mutual Water Company.....	330	60	180
Modesto Irrigation District.....	1,570	320	200
Ojai Power Company.....	70	50	40
Vacaville Water & Power Company.....	100	20	60
Anaheim Municipal Light & Water Works.....	30	0	10
Los Angeles Gas & Electric Company.....	0	0	10
Napa Valley Electric Company.....	330	10	50
Alexander Brown Electric Plant.....	10	0	0
Indian Valley Light & Power Company.....	20	0	0
Totals.....	186,560	13,650	48,460
Grand Total all classes.....210,000†			

* This table covers the entire territory outside of incorporated cities and towns and is exclusive of industrial institutions. The records of the reporting companies permit an accurate determination of the total number of consumers. The segregation of classes required, however, a certain amount of estimating.

† Consumers receiving more than one class of service have been counted as one consumer for the purpose of the total.

Table 2 shows the number of rural consumers classified as "agricultural" either automatically or by a study of each district by the local office. A comparison of these data with those of table 1 shows that 51,000 or 24 per cent of all rural consumers were farmers, that 49,800 or 97 per cent of the farmer consumers had electric lights, that 9,060 or 18 per cent used electricity for heating and cooking, and that 40,330 or 79 per cent used it for power.

Table 3 shows the extent to which electricity is being used in actual production in California farming. The electrically driven irrigation pump is the biggest part of this load, probably as much as 90 per cent. If this load had been evenly distributed over the entire field, each of the 40,330 farmers using electricity for power would have had an

TABLE 2

NUMBER OF AGRICULTURAL CONSUMERS* OF ELECTRICITY IN CALIFORNIA, SERVED BY PUBLIC UTILITIES; POWER COMPANY QUESTIONNAIRE, 1925

Name of company	Lights	Heating and cooking	Power
Southern California Edison Company.....	12,000	2,290	10,760
San Joaquin Light & Power Corporation.....	7,380	1,200	7,710
Pacific Gas & Electric Company.....	11,800	2,210	10,830
Southern Sierras Power Company.....	3,300	230	1,070
Coast Counties Gas & Electric Company.....	2,540	320	1,320
Great Western Power Company.....	1,670	500	2,040
Coast Valleys Gas & Electric Company.....	720	70	500
Western States Gas & Electric Company.....	3,530	410	3,120
San Diego Consolidated Gas & Electric Company.....	1,450	570	1,280
Midland Counties Public Service Company.....	410	30	340
Turlock Irrigation District.....	2,500	770	810
California Oregon Power Company.....	230	20	40
Escondido Mutual Water Company.....	330	60	180
Modesto Irrigation District.....	1,570	330	200
Ojai Power Company.....	30	20	40
Vacaville Water & Power Company.....	50	10	30
Anaheim Municipal Light & Water Works.....	20	10	0
Los Angeles Gas & Electric Company.....	0	0	10
Napa Valley Electric Company.....	260	10	50
Alexander Brown Electric Plant.....	10	0	0
Indian Valley Light & Power Company.....	0	0	0
Totals.....	49,800	9,060	40,330
Grand Total all classes.....	51,000†		

* In arriving at the agricultural constituent a farm was defined as follows: "A place will be called a farm that produces agricultural products and upon which either the owner, tenant, or hired help depends for his livelihood."

† Consumers receiving more than one class of service have been counted as one consumer for the purpose of the total.

average connected load of 15.77 horsepower; each would have used 17,678 kilowatt-hours a year; and each would have had a \$273 power bill. The average cost per kilowatt-hour would have been 1.55 cents at the meter.

Totals and averages taken from tables 1, 2, and 3 have been summarized in table 4, so as to present a concrete picture of the extent to which electricity is used as a source of power in California agriculture.

TABLE 3

CALIFORNIA AGRICULTURAL ELECTRIC POWER LOAD STATISTICS, EXCLUSIVE OF DOMESTIC USES; POWER COMPANY QUESTIONNAIRE, 1925

Name of company	Connected load (power only)	Total consumption (power only)	Revenue from agricultural load (power only)
	<i>horsepower</i>	<i>kilowatt-hours</i>	<i>dollars</i>
Southern California Edison Company.....	197,474	293,403,213	4,021,987.68
San Joaquin Light & Power Corporation.....	94,278	164,150,850	2,252,976.22
Pacific Gas & Electric Company.....	195,552	122,176,318	2,124,725.69
Southern Sierras Gas & Electric Company.....	21,489	40,752,863	678,750.00
Coast Counties Gas & Electric Company.....	15,459	13,266,126*	416,579.56*
Greast Western Power Company.....	41,000	17,807,000	345,700.00
Coast Valleys Gas & Electric Company.....	12,005	21,441,663	345,060.55
Western States Gas & Electric Company.....	23,935	8,018,260	239,512.49
San Diego Consolidated Gas & Electric Company.....	7,800	7,600,000	197,775.00
Midland Counties Gas & Electric Company.....	8,510	7,275,898	140,292.00
Turlock Irrigation District.....	8,500	7,900,000	113,000.00†
California Oregon Power Company.....	3,902	5,426,594	48,901.21
Escondido Mutual Water Company.....	755	566,368	20,741.96
Modesto Irrigation District.....	2,111	1,018,074	19,503.37
Ojai Power Company.....	1,641	1,045,996	17,933.22
Vacaville Water & Power Company.....	0	262,129	8,925.83
Anaheim Municipal Light & Water Works.....	500	263,985	6,120.00
Los Angeles Gas & Electric Company.....	286	349,505	5,269.36
Napa Valley Electric Company.....	590	189,161	4,925.27
Alexander Brown Electric Plant.....	112	33,484	1,097.39
Indian Valley Light & Power Company.....	17	0	917.35
Totals.....	635,916	712,947,487	11,010,694.15

* Includes power, heating, and cooking.

† Revenue shown for Turlock was estimated, but any errors will probably not exceed 10 per cent.

TABLE 4

SUMMARY OF CALIFORNIA RURAL ELECTRICAL STATISTICS COMPILED FROM DATA IN TABLES 1, 2, and 3; POWER COMPANY QUESTIONNAIRE, 1925

FROM TABLE 1	
Total number of rural consumers receiving service.....	210,000*
Total number of rural consumers receiving lights.....	186,560
Total number of rural consumers receiving heating and cooking.....	13,650
Total number of rural consumers receiving power.....	48,460
FROM TABLE 2	
Total number of farms receiving central station service.....	51,000*
Total number of farms using electricity for lights.....	49,800
Total number of farms using electricity for heating and cooking.....	9,060
Total number of farms using electricity for operating motors.....	40,330
FROM TABLE 3	
Total horsepower connected load, agricultural power only.....	635,916
Total kilowatt-hours consumed by agricultural power only.....	712,947,487
Total revenue agricultural load only (power).....	\$11,010,694.15
COMPUTED AVERAGES	
Average connected load horsepower (power only).....	15.77
Average annual consumption kilowatt-hours (power only).....	17,678
Average annual revenue (power only).....	\$273.01
Average price per kilowatt-hour.....	\$.0155
Per cent of farms in California that have central station service.....	40

* Consumers receiving more than one class of service have been counted as one consumer for the purpose of the total.

POSTCARD SURVEY

The postcard questionnaire was a cooperative undertaking between the committee on statistics, the power companies, and the farmers. Fifty thousand duo-fold postcards containing spaces for 57 answers on the number and size of appliances used, the acreage, and the crops grown, were prepared by the committee and delivered to the various power companies. These cards were mailed by the respective companies to their agricultural consumers. Out of this number 18 per cent were filled out and returned by the farmers.

Following is the postcard questionnaire sent to farmers:

Dear Sir:

The California Committee on Relation of Electricity to Agriculture is making a survey of the use of electricity on the farm in this state. The work of this committee is sponsored by such organizations as the California Grange, California Farmers' Educational and Cooperative Union, California Farm Bureau Federation, and the Pacific Coast Electrical Association, and is being directed by members of the College of Agriculture of the University of California.

The results of the survey are to be published in the California Farm papers. Your prompt answering and returning of this card will enable the committee to obtain a complete and accurate record of existing farm uses. This is an important part of the work of the committee whose duty it is to obtain complete information concerning the cost and efficiency of electricity as a kind of energy for the farm. Farmers in other parts of the United States are anxious to know the exact extent of the use of electricity in California.

It will only take a few minutes to fill out this card, so please do it now.

Yours truly,

BEN D. MOSES,

Executive Secretary, C. R. E. A.

Electric Motor used for	Total No. H.P.	Electrical Household Appliances	No.	Electric Lights	No.
1 Irrigation.....		20 Range.....		38 Residence Lights.....	
2 Water Supply.....		21 Hot Water Heater.....		39 Barn Lights.....	
3 Feed Cutter.....		22 Washing Machine.....		40 Shop Lights.....	
4 Silo Filler.....		23 Space Heater (Stove).....		41 Dairy Lights.....	
5 Shop.....		24 Sewing Machine.....		42 Pump House Lights.....	
6 Wood Saw.....		25 Vacuum Cleaner.....		43 Poultry House Lights.....	
7 Milking Machine.....		26 Flat Iron.....		44 Yard Lights.....	
8 Cream Separator.....		27 Mangle.....		45 Garage Lights.....	
9 Refrigerator.....		28 Percolator.....		46	
10 Dehydration Fan.....		29 Toaster.....		47	
11 Ventilator Fan.....		30 Waffle Iron.....			
12		31 Table Grill (Stove).....		MISCELLANEOUS	
13		32 Curling Iron.....		48 Electric Truck.....	
14 Total Number Motors.....		33 Immersion Heater.....		49 Horse Clippers.....	
15 Total H.P. Connected Load.....		34 Heating Pad.....		50 Sheep Shears.....	
16		35 Dish Washer.....		51 Brooder.....	
17 Number Acres Farmed.....		36 Portable Fan.....		52 Incubator.....	
18 Major Crop.....		37 Bell Transformer.....		53 Battery Charger.....	
19					

Other Uses and Remarks.....

Table 5 summarizes the returns as reported on the postcard questionnaires. The figures while representative, must be multiplied by some factor in order to obtain the totals for the entire state (see page 16).

TABLE 5

STATISTICS ON THE USES OF ELECTRICITY ON CALIFORNIA FARMS; COMPILED FROM
THE RETURNS OF THE POSTCARD SURVEY, 1925

ELECTRIC MOTORS		
Application	Number of units, survey total	Horsepower, connected load, survey total
Irrigation.....	7,929	131,109
Domestic water supply.....	2,493	4,815
Feed cutters.....	256	1,081
Silo fillers.....	23	352
Shop tools.....	280	592
Wood saw.....	81	279
Milking machines.....	274	550
Cream separators.....	313	85
Refrigerators.....	217	388
Dehydrator fans.....	120	1,566
Ventilator fans.....	122	118
Other uses.....	537	2,904
Totals.....	12,645	143,839

ELECTRIC HOUSEHOLD APPLIANCES	
Appliance	Number of units, survey total
Ranges.....	2,254
Water heaters.....	1,341
Washing machines.....	3,608
Room heaters.....	1,869
Sewing machines.....	1,281
Vacuum cleaners.....	3,571
Flat irons.....	6,950
Mangles.....	164
Percolators.....	1,839
Toasters.....	3,397
Waffle irons.....	1,294
Table grills.....	1,096
Curling irons.....	2,395
Immersion heaters.....	211
Heating pads.....	1,064
Dish washers.....	34
Portable fans.....	2,011
Bell transformer.....	995
Other uses.....	2,186

TABLE 5—*Continued*

ELECTRIC LIGHTS

Application	Number of lights, survey total
Residence.....	105,538
Barn.....	9,730
Shop.....	3,535
Dairy.....	3,732
Pump house.....	5,428
Poultry house.....	9,142
Yard.....	5,237
Garage.....	4,488

MISCELLANEOUS ELECTRICAL APPLIANCES

Appliance	Number of units, survey total
Electric trucks.....	4
Horse clippers.....	36
Sheep shears.....	4
Poultry brooders.....	879
Incubators.....	1,140
Battery chargers.....	1,025
Other uses.....	140

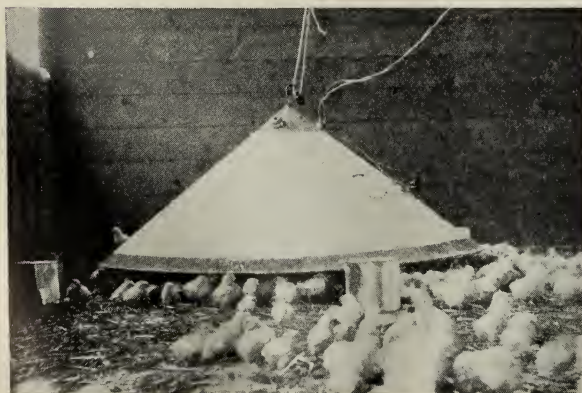


Fig. 1.—The raising of chicks by the use of artificially heated brooders has become a recognized practice with California poultrymen. Approximately 1,000 electrically heated brooders are now in use in California, with a combined capacity of approximately 10,000,000 chicks a year.

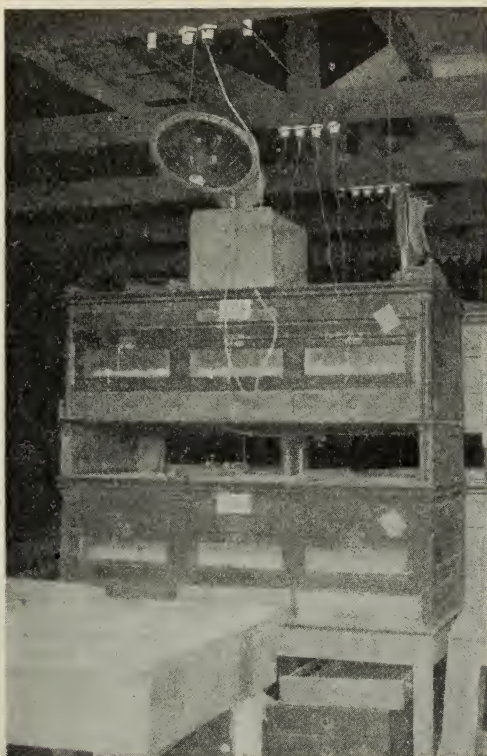


Fig. 2.—Electrically heated incubators are used by many individual poultrymen. This picture shows a section of a typical incubator room. The glow heater is placed above the testing table to prevent chilling of the eggs during the time they are removed from the incubator.



Fig. 3.—Electrically operated milk cooling and storage plant used on a 40-cow dairy in California, for producing market milk.



Fig. 4.—Precooling fruit by forcing air through the ice bunkers of cars is becoming a practice in California for shipments to Eastern markets. The system shown in the upper figure consists of a blower located outside of the car and the air is circulated throughout the car length. In the lower figure is shown a battery of fans which is placed in the center of the car to circulate the air through the ice bunkers. Precooling work takes place previous to starting the car in transit. Electric power is well adapted for this work.

CALIFORNIA RAILROAD COMMISSION REPORTS

Each privately owned public utility of California files with the California Railroad Commission an annual report of the business done under the commission's uniform system of accounts. These reports have been used as a basis in compiling tables 6, 7, 8, 9, and 10, the chief value of which is to show the trend in farm electrification. A comparison of these tables with tables 2, and 3, reveals certain differences which result from the omission of some of the smaller companies in the Commission reports and from the adjustment of returns by the power company statisticians to meet the agricultural classification as defined for tables 2 and 3.

The data compiled for the agricultural power load are taken from special agricultural power schedules, and show the extent of the use of electricity for motor and heating applications. They include no domestic uses, but cover connected load, power consumption, and revenue for the major companies from 1922 to 1928 inclusive.

Tables 6, 7, 8, 9, and 10 are summaries of the electric statistics for thirteen companies of California as reported to the California Railroad Commission. While they do not include publicly owned utilities and a few of the smaller privately owned companies, they do represent the major load of the state.

TABLE 6

NUMBER OF CONSUMERS SERVED ON AGRICULTURAL POWER SCHEDULES BY THIRTEEN POWER COMPANIES OF CALIFORNIA; CALIFORNIA RAILROAD COMMISSION REPORTS

Company	1923	1924	1925	1926	1927	1928†
California Oregon Power Company*	77	135	84	91	88	77
California Telephone & Light Company.....				752	832	792
Coast Counties Gas & Electric Company.....	700	850	950	1,063	1,003	1,122
Coast Valleys Gas & Electric Company.....	173	450	625	677	686	
Great Western Power Company.....	1,920	2,263	2,395	2,576	2,696	2,758
Midland Counties Public Service Company.....	122	299	396	469	502	558
Ontario Power Company.....	62	93	98	70	88	
Pacific Gas & Electric Company†.....	7,610	8,730	10,000	11,244	12,541	16,154
San Joaquin Light & Power Corporation.....	5,483	6,327	7,692	9,639	11,069	11,535
Southern California Edison Company†.....	8,700	9,718	10,757	11,904	12,487	13,473
Southern Sierras Power Company.....	830	912	1,052	1,134	1,195	1,278
San Diego Consolidated Gas & Electric Company....	741	870	996	1,137	1,229	1,320
Western States Gas & Electric Company.....	2,360	2,611	2,862	3,030	3,000	
Totals.....	28,778	33,258	37,907	43,786	47,416	49,067

* Includes power sold in Oregon.

† P. G. & E. includes Coast Valleys Gas & Electric Co. and Western States Gas & Electric Co.; Southern California Edison includes Ontario Power Company and Ojai Power Company.

TABLE 7

REVENUES TO POWER COMPANIES OF CALIFORNIA FOR ELECTRICITY SOLD ON AGRICULTURAL POWER SCHEDULES, NOT INCLUDING DOMESTIC LIGHTING NOR HEATING; CALIFORNIA RAILROAD COMMISSION REPORTS

Company	1923	1924	1925	1926	1927	1928†
California Oregon Power Company.....	<i>dollars</i> 80,000.00	<i>dollars</i> 87,297.36	<i>dollars</i> 80,990.95	<i>dollars</i> 101,778.93	<i>dollars</i> 98,532.58	<i>dollars</i> 102,661.57
California Telephone & Light Company.....						43,197.57
Coast Counties Gas & Electric Company.....		184,024.77	271,004.27	378,686.03	372,072.83	391,685.43
Coast Valleys Gas & Electric Company.....	280,000.00	313,437.26	345,060.55	394,224.83	401,773.94	
Great Western Power Company.....	288,405.88	357,048.26	345,711.39	391,522.19	418,619.81	409,807.56
Midland Counties Gas & Electric Company.....	58,846.93	121,339.68	140,537.07	184,366.05	181,553.96	203,663.98
Ontario Power Company.....	137,571.97	162,233.92	170,784.00	143,066.68	119,446.27	
Pacific Gas & Electric Company.....	1,727,140.21	2,226,602.88	2,086,338.49	2,467,631.64	2,575,250.24	3,376,922.19
San Joaquin Light & Power Corp.....	1,689,309.48	1,956,625.41	2,252,331.14	2,838,919.05	2,684,807.09	3,430,319.76
Southern Sierras Pwr. Company.....	455,257.36	555,755.70	669,280.11	689,203.36	660,015.06	814,278.71
Southern California Edison Company.....	3,376,265.62	3,550,266.20	4,021,987.68	4,379,253.76	3,984,601.45	5,305,588.93
San Diego Cons. Gas & Electric Company.....		160,609.55	197,775.02	224,265.79	196,368.19	225,463.80
Western States Gas & Electric Company.....	207,805.77	281,922.77	239,818.38	264,063.66	285,677.22	
Totals.....	8,300,603.22	9,957,163.76	10,821,619.05	12,456,981.97	11,978,718.64	14,303,589.50

* Includes power sold in Oregon.

† Pacific Gas & Electric Company includes Coast Valleys & Western States, and Southern California Edison includes Ojai Power Company & Ontario Power Co.

TABLE 8

CONNECTED LOAD IN KILOWATTS OF AGRICULTURAL USERS SERVED BY THIRTEEN POWER COMPANIES OF CALIFORNIA ON AGRICULTURAL POWER SCHEDULES; CALIFORNIA RAILROAD COMMISSION REPORTS

Company	1923	1924	1925	1926	1927	1928**
California Oregon Power Company*.....	3,240	4,015	3,280	4,452	4,750	4,408
California Telephone & Light Company.....	1,330	1,788	2,029	2,546	2,706	2,870
Coast Counties Gas & Electric Company.....	8,100	9,900	11,600	13,350	14,073	15,700
Coast Valleys Gas & Electric Company.....	8,072	9,619	12,005	13,378	14,064	
Great Western Power Company.....	23,012	24,561	24,946	25,896	26,445	26,755
Midland Counties Gas & Electric Company....	1,608	4,667	6,348	7,480	7,950	8,766
Ontario Power Company†.....						
Pacific Gas & Electric Company.....	119,500	131,000	143,100	151,355	160,807	196,000
San Joaquin Light & Power Corp.....	48,649	56,008	70,569	88,958	98,435	106,744
Southern California Edison Company.....	106,500	125,979	147,313	165,617	173,851	197,659
Southern Sierras Power Company.....	11,695	13,316	14,675	16,563	18,660	20,077
San Diego Consolidated Gas & Electric Company†.....	5,000	6,700	8,400	10,160	11,333	12,559
Western States Gas & Electric Company.....	16,000	17,458	21,506	19,086	20,000	
Totals.....	352,706	405,011	465,771	518,841	553,074	591,538

* Includes power sold in Oregon.

** Pacific Gas & Electric Company includes Coast Valleys Gas & Electric Company and Western States Gas & Electric Company; Southern California Edison includes Ojai Power Company and Ontario Power Company.

† No returns on connected load for the first 5 years but included in returns of Southern California Edison Co. for 1928.

‡ Estimated values based on 1926-1927 returns.

TABLE 9

ELECTRICITY USED IN KILOWATT-HOURS BY AGRICULTURAL USERS SERVED BY
THIRTEEN POWER COMPANIES OF CALIFORNIA ON AGRICULTURAL POWER
SCHEDULES; CALIFORNIA RAILROAD COMMISSION REPORTS

Company	1923	1924	1925	1926	1927	1928**
California Oregon Power Company*	7,147,625	12,257,131	7,623,747	9,565,835	9,240,857	8,838,284
California Telephone & Light Company.....		781,524	817,997	1,047,566	1,294,382	1,550,417
Coast Counties Gas & Electric Company.....				12,000,000	11,857,055	11,938,817
Coast Valleys Gas & Electric Company.....	12,520,380	18,888,908	21,441,663	23,492,641	22,279,781	
Great Western Power Company.....	12,242,000	19,954,000	17,807,000	21,860,000	24,366,000	24,535,000
Midland Counties Gas & Electric Company.....	3,113,396	6,707,203	7,275,898	9,852,932	9,017,949	10,592,704
Ontario Power Company.....	9,477,042	11,450,030	12,000,131	10,321,794	8,124,424	
Pacific Gas & Electric Company.....	98,829,742	140,138,025	121,358,321	157,278,780	160,359,741	201,740,961
San Joaquin Light & Power Corp.....	100,311,250	148,594,605	171,322,350	211,193,339	182,865,391	247,224,591
Southern California Edison Company.....	203,739,000	256,036,000	293,403,213	325,845,530	271,241,364	390,443,166
Southern Sierras Power Company.....	25,977,510	33,028,253	40,608,593	40,677,345	35,916,638	48,548,285
San Diego Consolidated Power Company†.....	5,216,000	7,160,000	7,680,000	9,607,671	7,613,961	10,850,000
Western States Gas & Electric Company.....	6,542,027	11,392,651	8,193,226	9,400,208	10,358,654	
Totals.....	485,115,972	666,388,330	709,532,139	842,143,641	754,536,197	956,262,225

* Includes power sold in Oregon.

** Pacific Gas & Electric Company includes Coast Valleys Gas & Electric Company and Western States Gas & Electric Company; Southern California Edison Company includes Ojai Power Company and Ontario Power Company.

† Estimated values based on 1926-1927 returns.

TABLE 10

SUMMARY OF TOTALS AND AVERAGES OF NUMBER OF CONSUMERS, CONNECTED
LOAD, ENERGY CONSUMPTION, AND COST TO FARMER OF ELECTRICITY SOLD BY
THIRTEEN POWER COMPANIES IN CALIFORNIA, ON AGRICULTURAL POWER
SCHEDULES; CALIFORNIA RAILROAD COMMISSION REPORTS

	1923	1924	1925	1926	1927	1928
Number of consumers.....	28,778	33,258	37,907	43,786	47,416	49,067
Total revenue.....	\$8,300,603.22	\$9,957,163.76	\$10,821,619.05	\$12,456,981.97	\$11,978,718.64	\$14,303,589.50
Kilowatts, connected load.....	352,706	405,011	465,711	518,841	553,074	591,538
Kilowatt-hours consumed annually.....	485,115,972	666,388,330	709,532,139	842,143,641	754,536,197	956,262,225
Connected load per consumer, kilowatts.....	12.28	12.21	12.32	12.15	11.69	12.05
Annual consumption, kilowatt-hours, per consumer.....	16,891	20,562	19,199	19,236	15,913	19,480
Price per kilowatt-hour, cents.....	1.71	1.47	1.49	1.48	1.59	1.41
Kilowatt-hours per kilowatt connected load....	1,383	1,657	1,536	1,603	1,350	1,616

ESTIMATED USE FOR THE ENTIRE STATE FOR 1925

A study of the quantities given in the previous tables brings out the need for some consistent method of extending the data obtained from the surveys so as to cover the entire state of California. The ratio of the total number of card questionnaires mailed out to the total number returned was 5.4, but because the farmers most likely to fill in and return the cards would be those who were favorable toward electricity, the returns should no doubt be multiplied by a smaller factor in order to obtain state-wide totals. The number of irrigation

TABLE 11

GENERAL STATISTICS* ON THE NUMBER OF CONSUMERS OF ELECTRICITY, ELECTRIC APPLIANCES, AND ELECTRICALLY DRIVEN MACHINES USED ON CALIFORNIA FARMS IN 1925

	Number of items	Horsepower, connected load
Motors (all sizes not including domestic).....	63,225	
Farms receiving central station service.....	51,000	
Lighting consumers.....	49,800	
Irrigation motors.....	39,600	656,000
Flatirons.....	34,800	
Washing machines.....	18,000	
Vacuum cleaners.....	17,800	
Toasters.....	17,000	
Domestic water supply motors.....	12,500	24,000
Curling irons.....	11,980	
Ranges.....	11,300	
Portable fans.....	10,000	
Percolators.....	9,200	
Space heaters.....	9,300	
Farms using electricity for cooking.....	9,060	
Water heaters (fixed type).....	6,700	
Waffle irons.....	6,420	
Sewing machines.....	6,400	
Incubators.....	5,700	
Table grills.....	5,480	
Heating pads.....	5,320	
Battery chargers.....	5,130	
Bell transformers.....	4,980	
Brooders.....	4,400	
Cream separators.....	1,570	430
Shop motors.....	1,400	2,960
Milking machines.....	1,370	2,750
Feed grinders.....	1,280	5,400
Refrigerators.....	1,090	1,940
Immersion heaters (portable type).....	1,060	
Ironing machines (mangles).....	820	
Dehydrator fans.....	600	7,800
Wood saws.....	400	1,400
Dish washing machines.....	170	
Silo fillers.....	115	1,760

* Based on post card questionnaire returns adjusted so as to include the entire state.

motors and the total irrigation connected loads are included in both the postcard survey and the power company questionnaire. Because of the special schedules used by the power companies in serving the agricultural consumer with power, their returns on the connected load and on the number of consumers furnish a definite basis for comparison. The ratio of the number of motors indicated on the power company questionnaire to that obtained from the postcard survey was 5.09, and the ratio of connected loads was 4.85. Because these factors, considered from different angles, came so close together, 5 was taken as a factor by which the returns on the postcards should be multiplied to give the number of each item for the whole state. The extended data are shown in table 11.

THE TREND OF AGRICULTURAL ELECTRIFICATION

The general trend of the use of electricity in agricultural production, exclusive of domestic uses, is indicated by figure 5. The diagram of the number of agricultural consumers resembles very closely that for the total connected load: they are both on the increase, and the change is uniform. The diagram for the revenue and that for kilowatt-hours consumed also resemble each other, but the upward tendency shown by both is less uniform than in the case of the diagrams for connected load and number of consumers.

The reason for this difference lies in the fact that a farmer who has an irrigation pump keeps it and consumes electric energy whether he has a light crop or a heavy crop, whether prices are high or low, whether water level is high or low, and whether the season is wet or dry. His connected load, too, remains more or less independent of these factors, but the extent to which he uses his electricity depends greatly upon the season, the condition of his well, and the efficiency of his machinery. In 1926, which was known as a dry year, the connected load and number of consumers for power varied very little from the uniform rate of increase, yet the consumption and revenue both took a jump, while the reverse was true in 1927. This can at least in part be explained by the fact that 1927 was a more favorable crop year from the standpoint of rainfall than was 1926. Both the amount of rain and the time it falls affect the pumping demand.

Table 10 shows plainly that while both the connected load per consumer and the price per kilowatt-hour are fairly constant throughout the years 1923 to 1928 inclusive, there is a tendency towards a slightly smaller plant; but there is little reduction in the overall revenue to the power company per kilowatt-hour consumed.

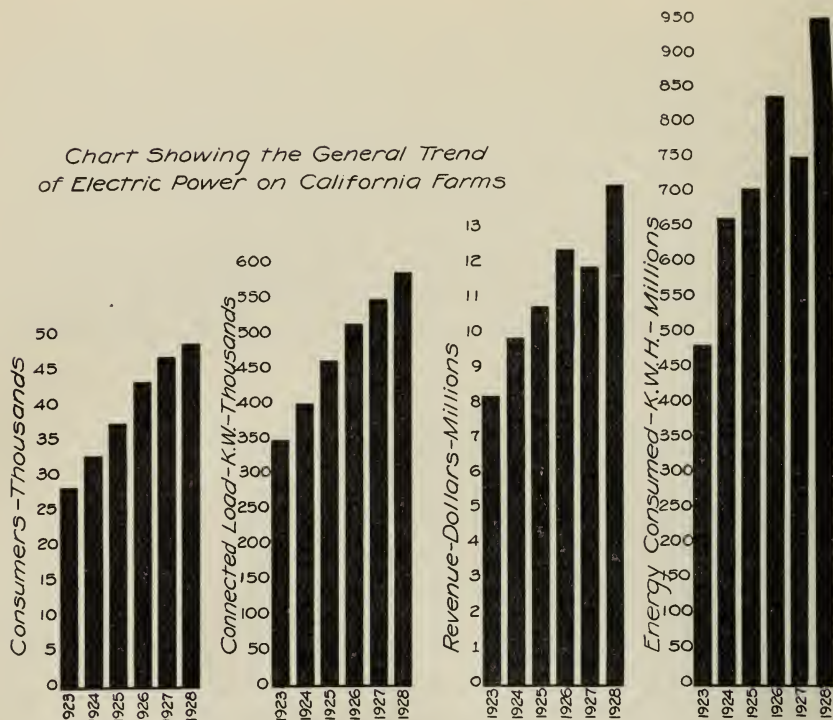


Fig. 5.—The general trend of the use of electricity on California farms is upward. The increase in the number of consumers and in the connected load is practically independent of seasonal conditions, but the consumption and revenue depend on rainfall, temperature, and other factors affecting the crops. These charts are taken from annual reports made to the California Committee on the Relation of Electricity to Agriculture by thirteen of the power companies selling power to the farm, and represent the major load.

That the trend is upward in each of the large agricultural areas of California is also evident from the monthly curves, figure 6, of three of the larger companies. One serves a large section in the southern part of the state, another the San Joaquin Valley and central part, and the third the Sacramento Valley and northern part.

This power load is decidedly peaky in its characteristic for each of the companies, having a high peak in midsummer when irrigation is heavy and a low valley in midwinter when there is little or no irrigation. Sufficient energy must be furnished in the winter to take care of heating of brooders and incubators and sterilizers, and for operating small motors such as are used on dairies, poultry ranches and stock farms, but this is very small compared with the irrigation load

in the summer months. This seasonal characteristic may or may not be helpful to the power company depending upon its other loads and upon its system of generation and distribution of electricity.

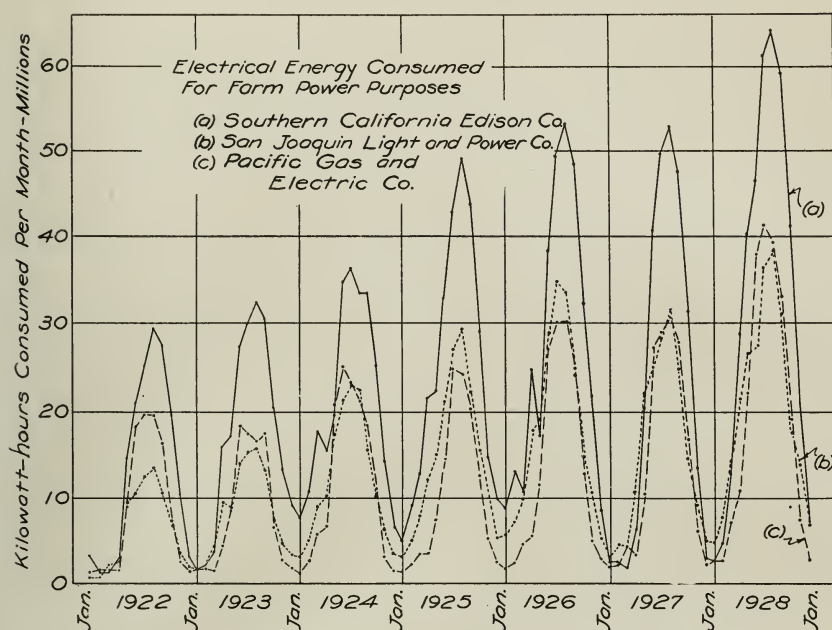


Fig. 6.—Chart showing the monthly characteristics of electrical energy consumed by California farmers, for power purposes only (mostly irrigation), for three representative companies in the large agricultural areas.

The previous tables and charts show that the California farmer already uses electricity extensively and that the trend is upward. They also show that the heaviest farm load occurs in the summertime, that the peak appears in July or August, and the valley in January, and that over fifty per cent of the energy used for power purposes is consumed during the months of June, July, August and September. The operation of smaller equipment for a longer period of time and the adoption of more extensive winter uses such as room and water heating, brooding, and hatching, are two methods of filling in the low valley during the winter months.

The farmer and the utility are therefore mutually dependent upon each other, the one to spread his uses over a longer period of time, and the other to make it profitable for him to do so.

The accompanying tables and charts may, it is hoped, serve to show to some degree the extent of the present uses and to stimulate activities that will make possible the development of the farm uses in such a way as to further the interests of the farmer.

ACKNOWLEDGMENTS

The writer is indebted to Mr. N. R. Sutherland of the Pacific Gas and Electric Company, San Francisco, to Professor C. M. Titus of the University of California, Davis, and to Mr. L. S. Wing of the California Farm Bureau Federation for their valuable assistance in compiling the data and editing the manuscript; to Mr. E. D. Murray of the California Railroad Commission, San Francisco, for making available the annual reports; to Mr. A. G. Cage of the Southern Sierras Power Company, Riverside, Mr. Lloyd Henley of the San Joaquin Light & Power Corp., Fresno, Mr. R. Jenny of the Pacific Gas & Electric Company, San Francisco, Mr. W. C. McWhinney of the Southern California Edison Company, Los Angeles, Mr. R. J. O'Connell of the Modesto Irrigation District, Modesto, Mr. R. A. Sharon of the Great Western Power Company, San Francisco, and Mr. R. W. Shoemaker, of the Turlock Irrigation District, Turlock, for furnishing statistics of their respective loads. The power utilities and irrigation districts helped in obtaining the postcard survey. The response of the farmers and the promptness in filling out and returning the postal card questionnaires is also appreciated.